Miniature Rechargeable Battery for *bion*® Microstimulator

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Introduction

- ❑ *bion*® Microstimulator
  - ▪ A battery-powered microstimulator (manufactured by Advanced Bionics*)
  - ▪ Implanted next to peripheral nerves to restore function and/or provide electrical stimulation therapy (Fig.1)
- ❑ Current battery technology employed
  - ▪ Lithium ion battery using organic-solvent-based electrolytes
  - ▪ Problems: battery life; safety (possibility of flammable electrolyte leakage)

Challenges

- ❑ Battery calendar life
  - ▪ More than 10 years at human body temperature
- ❑ Safety
  - ▪ Stable, nonflammable and non-toxic electrolyte

Argonne's Approach

- ❑ Develop siloxane-based electrolytes
  - ▪ Nonflammable, thermally and electrochemically stable, non-volatile, and less toxic
  - ▪ Polymer electrolytes (Fig. 2) avoid leakage problems
- ❑ Battery chemistry optimization for siloxane-based system
  - ▪ Electrode material and engineering
  - ▪ Operating conditions

Results

- ❑ Very good conductivity of around 6 x 10^{-4} S/cm for the siloxane polymer electrolytes (Fig. 3)
- ❑ Safety: no reaction up to 360°C while conventional electrolyte is stable only to 150°C in the battery (Fig. 4)
- ❑ Performance stability: better capacity retention than lithium-ion technology at human body temperature (Fig. 5)
- ❑ Lifetime of more than 12 years is predicted based on current performance data

Potential Benefits of This Technology

- ❑ Potential beneficiaries
  - ▪ An estimated 50 million people in the U.S. suffer from conditions that may benefit from treatment with microstimulators (see Fig. 1).
- ❑ Potential market
  - ▪ The total worldwide market for neurostimulation devices is estimated to be $1.6 billion in 2004 and is expected to grow substantially over the next several years, reaching approximately $3.8 billion by 2010.

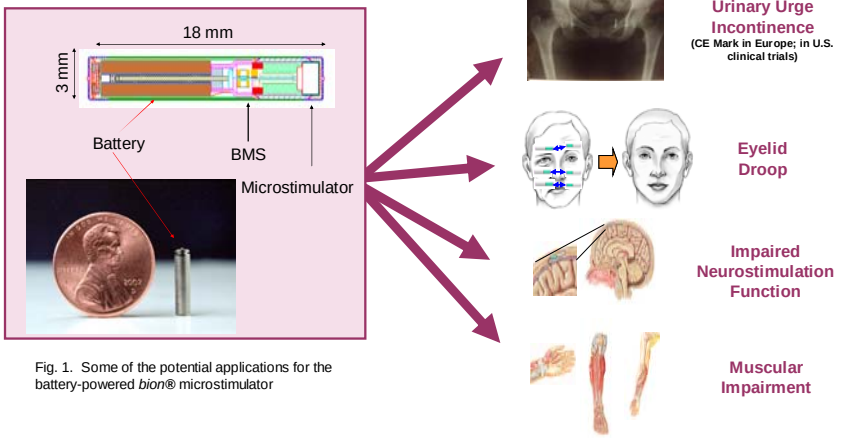

Fig. 1. Some of the potential applications for the battery-powered *bion*® microstimulator

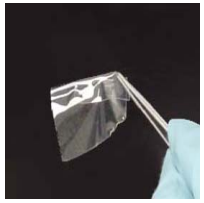

Fig. 2. The siloxane polymer electrolyte may extend battery life to more than 12 years at human body temperature.

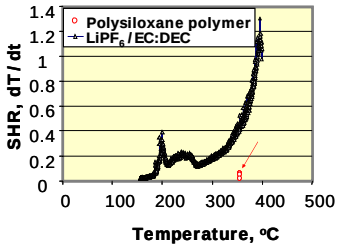

Fig. 4. Safety Comparison: siloxane electrolytes are stable up to 360°C with almost no heat generation, while the **organic-solvent-based electrolytes** begin reacting at 150°C and generate significant heat. (ARC data from siloxane polymer electrolytes vs. LiPF6/EC:DEC in the presence of lithium metal.)

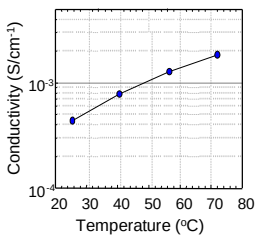

Fig. 3. Conductivity of siloxane electrolyte at various temperatures.

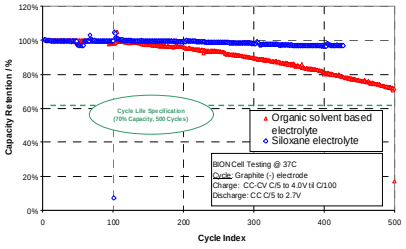

Fig. 5. Comparison of cycling performance of battery cells at 37°C : siloxane electrolyte and organic-solvent-based electrolyte.

The development of the miniature rechargeable battery is a collaborative project between Argonne, Quallion LLC, the University of Wisconsin and the Alfred Mann Foundation. The battery management system was developed jointly by the Alfred Mann Foundation and Advanced Bionics.

" *bion*® " is a registered trademark of Advanced Bionics Corporation.

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